

# Association between Molar Incisor Hypomineralization and Both Prenatal and Postnatal Factors in 8-10-Year-Old Children in Ardebil

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## ABSTRACT

### BACKGROUND

Molar incisor hypo-mineralization is a malformation with a systemic background for which aetiology is not well defined. Prevalence of these lesions varies in different countries, but few studies have been conducted on its prevalence in the Iranian society. The aim of this study was to determine the prevalence of molar incisor hypomineralization among 8-10-year-old children in Ardabil and its relationship with prenatal and postnatal factors.

### METHODS

In this analytical cross-sectional study, participants included 520 children from public schools of Ardabil. In the first stage, the frequency of MIH was determined by a clinical examination based on the index introduced by Tourino et al. Then, they were evaluated in two groups (with or without incisor hypo mineralization) to determine the causative factors. To collect information, a questionnaire including information about factors before and after birth was used. Data were analysed using SPSS 18 software. Chi-square and T-test and logistic regression were used to test the relationship between different factors.

### RESULTS

The prevalence of molar-incisor hypo mineralization in children aged 8-10-year-old in Ardabil was estimated to be 24 %. The results also showed that there is a significant relationship between prenatal and postnatal factors ( $p < 0.05$ ).

### CONCLUSIONS

Due to the high prevalence of MIH in Ardabil, preventive measures, informing the parents and periodic examination of the teeth are recommended.

### KEY WORDS

MIH, Prevalence, Aetiology

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## BACKGROUND

Molar-Incisor Hypomineralisation (MIH) is characterized by asymmetric opacities with a systemic origin, affecting one to four permanent first molars, which can manifest themselves in anterior permanent teeth.<sup>1</sup>

MIH was first introduced as a new type of enamel lesion by Koch, and then the term MIH was used by Weerheijm in 2001, meaning a type of developmental defect in enamel and hypomineralization with systemic origin.<sup>2</sup> The prevalence of MIH in different populations varies depending on the age of the subjects, methodological differences and the criteria used in diagnosis. Studies show that the lowest prevalence is observed among Chinese children (2.5 %).<sup>3</sup> Tourino et al's study (2016) on 1181 Brazilian children estimated the prevalence of MIH to be 20.4 %.<sup>4</sup> In 2013, Garcia et al., conducted a study on 840, 9-year-old children from Spain and reached to the conclusion that the prevalence of MIH was about 21.8 %.<sup>5</sup> Ahmadi et al. (2012) investigated the prevalence of MIH on 433 children aged 7 – 9 in Zahedan.<sup>6</sup> The prevalence of MIH was about 12.7 %. Although its aetiology is not yet well understood, the evidence suggests that systemic factors affect the lesions at different stages of tooth development. Enamel formation of the permanent first molar begins from the 28<sup>th</sup> week of the embryo until the first ten days of birth. Given that ameloblasts are the most sensitive cells in the body, any slight changes in the environment can cause temporary or permanent damage to them and may cause hypoplasia (damage to the matrix formation) or hypomineralisation (damage at calcification or maturation stage). Among the possible causes, type of delivery and its associated problems such as fever and decreased oxygen supply to the mother or child's tissues, respiratory infections, low birth weight, and electrolyte imbalance in premature infants, calcium and phosphorus metabolism disorders, and diseases repeated during the first three years of life, antibiotic consumption, as well as the combination of several aetiological agents that reinforce each other can be mentioned.<sup>6-8</sup> However, geographical differences can address the role of genetics in its aetiology to explain the prevalence of MIH and the indefinite reason of the lesions.<sup>9</sup> Although many studies have investigated the potential factors involved in the occurrence of MIH, the findings are mixed and contradictory.<sup>4,6,10</sup> Due to the uncertainty of prenatal and postnatal factors in the prevalence of MIH, this study aimed to investigate the prevalence of MIH among 8-10-year-old children in Ardabil and its relationship with prenatal and postnatal factors in Ardabil schools during 2018 - 2019.

## METHODS

This research was an analytical cross-sectional study in two stages. The population was 8 - 10 years old children from primary schools in Ardabil, Iran. In the first phase of the study, because there is a wide variation in the socioeconomic conditions of the population in different areas of the city, the city was classified into 4 zones, north, south, east and west, and 4 schools were randomly selected in each zone. In each school, based on student numbers, 30 - 35 students were randomly chosen and examined. According to Salem et al. (2016) and

other previous studies, the 95 % confidence interval with 2.5 % error rate was considered and final sample size calculated was 520.<sup>11</sup> Inclusion criteria included: children aged 8 to 10 years and willingness to cooperate with examinations. The consent form were taken from children or their parents before any examination. Exclusion criteria included: 1. The presence of enamel or dentin lesions in all teeth or a number of them done based on the specific diagnostic criteria for such lesions (Amelogenesis imperfecta, dentinogenesis imperfecta, and fluorosis). 2. Chronic hypoplasia, such as a history of infection or trauma to the anterior teeth. All dental examinations conducted in the schools using a headlight, and flat dental mirrors. After cleaning the teeth (permanent first molars and maxillary and mandibular incisors) with gauze, the wet teeth were examined by a calibrated examiner to investigate opaque stains and surface damage. Enamel defects are determined as follows:

### Grade 1 Lesions

Discoloration from white, milky to yellowish-brown in the upper part with a clear border less than 2 mm.

### Grade 2 Lesions

Tooth decay; enamel defect indicating loss of tissue after tooth eruption; this is often associated with opacity.

### Grade 3 Lesions

Unusual restoration; the size and shape of the restoration are inconsistent with the usual appearance of caries. In most cases, restorations that extend to buccal and palatal surfaces are found in the molar. Opacity is often observed on the margin of restoration. In incisor teeth, buccal restorations are unrelated to trauma.<sup>12,13</sup>

From 520 children who were examined 125 subjects were diagnosed as MIH. In order to complete the second phase of the study, the students selected as MIH for the first stage were considered the case group. The control group participants were the same age children studying in the same school and class. Children with the diagnosed disorders were compared with healthy children. The research checklist completed by both groups included demographic questions and questions about possible intervening factors in lesions including prenatal factors such as preeclampsia, medicine consumption to prevent premature labour, paracetamol use (Acetaminophen), premature birth, oxygen device without intubation, and postnatal factors including duration of breastfeeding, illness up to age 4, pneumonia, asthma / bronchitis, antibiotics consumption, analgesics, asthma medication, history of hospitalization and fever above 38.5° C. Mothers were given the opportunity to re-announce items other than the questions raised.

### Statistical Analysis

The statistical analysis methods of chi-square for qualitative variables, fisher test to multivariable factors and logistic

regression to show correlation between variables were done using SPSS version 23 (IBM SPSS Statistics 23).

## RESULTS

The sample comprised of 242 (46.7 %) male and 278 (53.3 %) females. The results of this study showed that the prevalence of MIH among children aged 8 - 10 years old in Ardabil is 24 %. However, the chi-square statistics did not reveal any significant differences between boys (25.2 %) and girls (23 %) ( $p = 0.316$ ). The results of chi-square test showed that prenatal factors did not affect the prevalence of MIH in 8 - 10 year-old children in Ardabil ( $p > 0.05$ ) (Table 1).

Factors		Affected		Unaffected		Chi-Square	P-Value
Prenatal Factors	Preeclampsia	Yes	0	0	0	0.635	0.577
		No	125	24.1 %	395	75.9 %	
	Taking medicine to prevent premature labour	Yes	6	20 %	24	80 %	0.284
		No	119	24.3 %	371	75.7 %	0.389
	Taking paracetamol (acetaminophen)	Yes	20	26.7 %	55	73.3 %	0.332
		No	105	23.6 %	340	76.4 %	0.328
	Premature birth	Yes	7	17.9 %	32	82.1 %	0.856
		No	118	24.5 %	363	75.5 %	0.237
	Using oxygen device without intubation	Yes	2	66.7 %	1	33.3 %	3
		No	123	23.8 %	394	76.2 %	0.145

**Table 1. Effect of Prenatal Factors on MIH**

Factors		Affected		Unaffected		Chi-Square	P-Value
Postnatal factors	Breastfeeding more than 6 months	Yes	105	24.2 %	329	75.8 %	0.035
		No	20	23.3 %	66	76.7 %	0.487
	Breastfeeding less than 6 months	Yes	16	32.7 %	33	67.3 %	2.199
		No	109	23.1 %	362	76.9 %	0.098
	Disease up to 4 years old	Yes	13	31 %	29	69 %	1.20
		No	112	23.4 %	366	76.6 %	0.181
	Pneumonia	Yes	7	46.7 %	8	53.3 %	4.33
		No	118	23.4 %	387	76.6 %	0.044
	The effect of asthma / bronchitis	Yes	9	64.3 %	5	35.7 %	12.76
		No	116	22.9 %	390	77.1 %	0.001
	Use of antibiotics	Yes	41	31.3 %	90	68.7 %	5.054
		No	84	21.6 %	305	78.4 %	0.018
	Use of analgesics	Yes	32	33 %	67	67 %	5.023
		No	93	22.1 %	328	77.9 %	0.017
	Taking medication for asthma	Yes	10	58.8 %	7	41.2 %	11.64
		No	115	22.9 %	388	77.1 %	0.002

**Table 2. Effect of Postnatal Factors on MIH**

The Variables Remained in the Model	Beta	95 % Confidence Interval	Valid Statistics	DF	Odds Ratio	P-Value
Asthma / bronchitis	0.524 1	0.580	6.906	1	6.20	0.009
The history of hospitalization	0.500 0	0.251	3.985	1	1.19	0.046
Fever above 38.5 C	0.466 0	0.241	3.844	1	1.24	0.049
Contingency coefficient	0.471 -1	0.136	117.75	1	0.34	0.000

**Table 3. Results of Multivariate Logistic Regression**

As it is shown in table 2 the results of postnatal factors on the prevalence of MIH showed that factors such as pneumonia,

asthma / bronchitis, antibiotics consumption, analgesics, asthma medication, history of hospitalization and fever above 38.5 C had a significant effect on the prevalence of MIH ( $p < 0.05$ ). Therefore, these variables were entered into the multiple logistic regression model as a predictor variable for MIH. A total of 520 people were included in the analysis.

Multiple logistic regression results showed that only the variables of asthma / bronchitis, hospitalization history, and fever above 38.5 C could predict MIH ( $p < 0.05$ ) (Table 3).

## DISCUSSION

In this descriptive-analytic study, prevalence of MIH among 8-10-year-old children in Ardabil was 24 %. In three other Iranian studies published by Ahmadi et al (2012) in Zahedan, the prevalence of MIH in 433 children aged 7 to 9 years was 7.12 %.<sup>6</sup> Ghanim et al (2013) conducted a study on 810 children aged 9 to 11 years in Shiraz and concluded that the prevalence of MIH was 20.2 %.<sup>5</sup> In 2016, Salem et al reported the prevalence of MIH to be 13.5 % among children aged 6 to 13 years in rural areas of Masal and Shandman.<sup>11</sup> However, in 2001, in a review study, Werhijm reported the prevalence of MIH in different populations to vary from 3.6 to 25 %.<sup>12</sup> Parikh et al. conducted a study on 1,366 Indian children aged 8 to 12 years and reported the prevalence of MIH to be 9.2 %.<sup>13</sup> A UK study in 2015 reported the prevalence of MIH to be 15.5 %.<sup>14</sup> This study was conducted by Balmer et al.

The differences observed in the prevalence of MIH in different studies appear to be due to age differences, ethnic and racial differences, geographical differences, environmental factors, MIH evaluation criteria, and participants' inclusion and exclusion criteria.<sup>6,15</sup> Studies conducted on European populations have reported the prevalence of MIH to be 10 % among the Swedish and the Dutch, 6 % among the German, 16 % among the Italian, 5 % among the Bulgarian, and 28 % among the Danish, while its prevalence in African countries such as Kenya, Libya and Hong Kong, and Brazil is reported to be 14 %, 3 %, and 40 % respectively.<sup>11</sup>

The results also showed that there was no significant difference in MIH of two sexes. This finding is similar to the findings of Ahmadi and studies conducted about Jordan, Spain, Singapore, Nigeria.<sup>6,16-20</sup> On the contrary, in other studies the prevalence and severity of MIH was reported to be different in two sexes.<sup>16,21</sup> This study attributed this difference to the inconsistency of dental crown completion, tooth eruption, and oral hygiene in both boys and girls.<sup>19,21</sup> The results also showed that there is no significant difference in MIH based on parental education and family income; this result is consistent with the studies of Salem et al., Costa, Boindi, Muratbegovic, Sonmez, Jeremias, Arrow.<sup>7,11,15,22-24</sup> One of the main goals of this study was to determine the probable predictive factors (pre- and postnatal factors) of MIH. For this purpose, significant variables in Fisher's exact test were entered into logistic regression and the results showed that only asthma / bronchitis variables, history of hospitalization and fever above 38.5 degrees C may be effective factors in MIH.

Tourino et al's study (2016) on 1181 Brazilian children showed that children who experienced asthma and bronchitis in the first four years of their life were 1.45 - 2.56 % more likely

to be affected by MIH than normal children.<sup>4</sup> Any infection, especially respiratory tract infection, such as the common cold, can cause frequent high fever (fever more than 5 times during the first year of life is considered as recurrent childhood fever). Stable high fever causes improper orientation of enamel prisms and crystal-free regions.<sup>8,25,26</sup>

Seizures are also a common cause of MIH in children. Febrile seizures are called high fever seizures and are thus linked to the prevalence of MIH. Fever-induced seizures are also associated with neonatal hypocalcemia.<sup>8,27</sup> The results of this study are in line with those of Tourino et al. (2016); Lygidakis et al. (2008); Ghanim et al. (2013); Alaluusua et al. (2010); Pitiphat et al. (2014); Souza et al. (2012).<sup>8,28-30</sup> In these studies, researchers identified asthma / bronchitis, hospitalization history, and fever above 38.5 degrees as MIH predictive variables. However, the results of this study showed that preeclampsia, medicine consumed to prevent premature labor, acetaminophen, premature birth, oxygen device without intubation, duration of breastfeeding, pneumonia, use of antibiotics and analgesics, asthma medications are not among the factors affecting the MIH among 8-10-year-old children in Ardabil. Previous related studies have shown that these factors have an influence on MIH.<sup>3,4,6,23,28,29,31-34</sup> The difference between the results of this study and those mentioned can be attributed to differences in the statistical population, race, age of children, inclusion and exclusion criteria. Lack of specific causation in the incidence of MIH may also reinforce the possibility of genetic influence on lesions. For this reason, differences in factors affecting MIH may also be related to differences in genetics of Iranian ethnic groups, although broader epidemiological studies of genetics and homogenization of research methods across different parts of the country are needed to confirm this hypothesis.<sup>9,18,19,35</sup> This is also statistically debatable; one of the recently published papers suggested a minimum sample size of 300 to investigate the prevalence of MIH and 1000 to investigate the aetiology.<sup>36</sup> Considering the sample size of the present study, the method proposed by the European Academy of Paediatric Dentistry (EAPD) and cluster sampling method covering all community groups, it seems that the results of this study (prevalence of MIH) can be generalized to all children aged 8 - 10 years old in Ardabil, but it requires more than 1,000 children to investigate its aetiological factors, so further studies with larger samples are recommended. Various aetiological factors have also been proposed in relation to the incidence of MIH, however, a precise relationship has not yet been established between these factors and the incidence of lesions. It seems that it is necessary to do a research on the molecular mechanisms that cause abnormal function of ameloblasts to obtain deeper information on MIH lesion, although the genetic context of this lesion cannot be ignored.<sup>37</sup>

## CONCLUSIONS

Considering the aforementioned cases, it seems that exposure to MIH cases requires extensive and multidisciplinary evaluation of the patient's condition, and long-term follow-up of treatments, and even their reformation. Overall, it seems that MIH is caused by a variety of factors.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.

Disclosure forms provided by the authors are available with the full text of this article at jemds.com.

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